

## CLAIMS

1. A direct-current converter which alternately switches on/off  
a main switch and an auxiliary switch, thereby rectifying and  
5 smoothing a voltage of a secondary winding of a transformer,  
thus obtaining a direct-current output, the main switch being  
connected in series to a primary winding of the transformer,  
and the auxiliary switch being of a series circuit connected  
to both ends of the primary winding of the transformer or both  
10 ends of the main switch and composed of a capacitor and the  
auxiliary switch, comprising:

bottom detection means configured to detect a minimum  
voltage of the main switch after the auxiliary switch is switched  
off;

15 control signal generation means configured to generate  
an ideal control signal which switches on the main switch at  
a time of the minimum voltage of the main switch based on an  
output of the bottom detection means;

error calculation means configured to calculate an error  
20 output between the ideal control signal generated by the control  
signal generation means and an actual control signal which  
switches on the main switch; and

delay control means configured to control a delay of an  
ON time of the main switch by the actual control signal based  
25 on the error output of the error calculation means, thereby  
performing control to make the actual control signal approach

the ideal control signal.

2. A direct-current converter which switches on/off a main switch connected in series to a primary winding of a transformer, thereby  
5 rectifying and smoothing a voltage of a secondary winding of the transformer, thus obtaining a direct-current output, comprising:

bottom detection means configured to detect a minimum voltage of the main switch when a voltage of the main switch  
10 is decreased;

control signal generation means configured to generate an ideal control signal which switches on the main switch at a time of the minimum voltage of the main switch based on an output of the bottom detection means;

15 error calculation means configured to calculate an error output between the ideal control signal generated by the control signal generation means and an actual control signal which switches on the main switch; and

delay control means configured to control a delay of an  
20 ON time of the main switch by the actual control signal based on the error output of the error calculation means, thereby performing control to make the actual control signal approach the ideal control signal.

25 3. The direct-current converter according to claim 1, further comprising: integration means configured to integrate the error

output of the error calculation means,  
wherein the delay control means controls the delay of the  
ON time of the actual control signal based on an integrated output  
of the integration means, thereby performing the control to make  
5 the actual control signal approach the ideal control signal.

4. The direct-current converter according to claim 2, further  
comprising: integration means configured to integrate the error  
output of the error calculation means,  
10 wherein the delay control means controls the delay of the  
ON time of the actual control signal based on an integrated output  
of the integration means, thereby performing the control to make  
the actual control signal approach the ideal control signal.

15 5. The direct-current converter according to claim 3,  
wherein the delay control means comprises:  
a delay unit which delays a signal switching on the main  
switch, the signal being from the control means, by a  
predetermined time by means of a charging time for a delaying  
20 capacitor connected in series to a resistor; and  
a variable delay unit which applies a difference voltage  
between the integrated output of the integration means and a  
reference voltage to the delaying capacitor, thereby shortening  
the predetermined delay time in response to the difference  
25 voltage, and  
the delay control means applies the actual control signal

to a control terminal of the main switch based on a voltage of the delaying capacitor.

6. The direct-current converter according to claim 4,

5       wherein the delay control means comprises:

      a delay unit which delays a signal switching on the main switch, the signal being from the control means, by a predetermined time by means of a charging time for a delaying capacitor connected in series to a resistor; and

10       a variable delay unit which applies a difference voltage between the integrated output of the integration means and a reference voltage to the delaying capacitor, thereby shortening the predetermined delay time in response to the difference voltage, and

15       the delay control means applies the actual control signal to a control terminal of the main switch based on a voltage of the delaying capacitor.

7. The direct-current converter according to claim 1, wherein

20       a direct-current power supply or a rectified voltage unit which obtains a rectified voltage by rectifying an alternating-current voltage of an AC power supply is connected to both ends of a series circuit composed of the primary winding of the transformer and the main switch.

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8. The direct-current converter according to claim 2, wherein

a direct-current power supply or a rectified voltage unit which obtains a rectified voltage by rectifying an alternating-current voltage of an AC power supply is connected to both ends of a series circuit composed of the primary winding of the transformer  
5 and the main switch.